

## REMARKS

### **Amendments**

Claims 45, 47, 48, 50, 51, and 53 are indicated as being allowable. Among these, claims 45, 48, and 51 have been amended to place them in independent form by incorporating essentially the language of the independent claims 1, 21, and 25 from which they respectively directly depend.

Claims 47, 50 and 53 respectively depend from claims 46, 49, and 52. Claims 46, 49, and 52 have been amended to place them in independent form by incorporating a substantial portion of the language of the independent claims from which they depend but modifying the recitation of the support to comprise a non-refractory oxide bulk material.

New claims 65-94 are added to the specification. These claims depend either directly or indirectly from one of the independent claims 45, 46, 48, 49, 51 and 52.

### **Restriction**

The Examiner's restriction and the withdrawal from consideration of claims 54-64 is acknowledged.

### **§112 Rejection of claims 46, 49, and 52**

It is respectfully submitted that the amendments to claims 46, 49, and 52 that place them in independent form are sufficient to obviate this §112 rejection.

### **§103(a) Rejection of claims 1-2, 9, 11-21, and 24 over Frame (US 3,978,137) in view of Yoo (US 3,945,914) and Mahadev (WO 92/20621), as evidenced by Clavenna (US5,476,877).**

The primary reference of Frame teaches a process for the oxidation of sulfur compounds using a catalyst system that comprises both a Group VIIB (e.g. manganese and rhenium) metal phthalocyanine and a Group VIII (e.g. cobalt, iron, nickel, palladium, rhodium, ruthenium, osmium, iridium, and platinum) metal phthalocyanine.

The secondary reference of Yoo teaches a two-step process involving a first step of oxidation of sulfur contained in a hydrocarbon material in the presence of an oxidant and, preferably, a metal-containing catalyst, see e.g. column 2, lines 46-63, followed by contacting the oxidized sulfur-containing hydrocarbon material with a metal-containing compound under

certain temperature conditions so as to form a metal-sulfur-containing compound. See e.g. column 1, lines 50-61; and column 7, lines 10-30. The preferred catalyst metals for the oxidation catalyst are Group IVB, Group VB, and Group VIB metals. See column 4, lines 7-10. The Examiner uses the Yoo patent to supply teachings concerning the amount of oxygen that may be in the hydrocarbon feed.

The third reference of Mahadev discloses a process for the removal of hydrogen sulfide and other sulfur compounds from sour natural gas and other fluid streams and the conversion of the sulfur therein to elemental sulfur. See e.g. page 1, lines 9-19. The Examiner uses the Mahadev publication to supply teachings concerning concentration ranges for sulfur compounds contained in a natural gas feedstream.

The fourth reference of Clavenna et al. discloses a particulate solid that can promote heat and mass transfer in a reacting gas phase in the production of syn gas. See Column 2, lines 30-52. The particulate solid may be a component of an admixture of a contact mass that includes the particulate solid and a catalyst component. See Column 2, lines 30-52. The particulate is generally characterized as a fluidizable precalcined zirconia that contains from 0 to about 1 percent silica. See Column 2, lines 39-42; column 4, lines 15-18. The precalcined particulate zirconia may be stabilized with about 1 to about 25 percent yttria. See Column 2, lines 60-64. The precalcined particulate may be used as a catalyst support by impregnation thereof or coprecipitation therewith a catalytically active metal. See Column 2, line 64 – column 3, line 6.

The zirconia stabilized with yttria material of Clavenna et al. has superior agglomeration resistance with excellent structural integrity. See Column 4, lines 18-21; column 7, lines 14-19. The zirconia particles are highly resistant to sintering, attrition, and agglomeration and impart high resistance to sintering, attrition and agglomeration of the catalyst. See Column 4, lines 18-24. The low silica yttria-stabilized zirconia catalyst of Clavenna et al. is used in processes for the production of syn gas (hydrogen and carbon monoxide) via the reaction of low molecular weight hydrocarbons, primarily methane, with steam. See Abstract; column 1, lines 25-34; column 2, lines 34-38; claim 1. The process for making syn gas from lower molecular weight hydrocarbons is something significantly different than a process for the catalytic selective oxidation of sulfur compounds contained in a hydrocarboneous feedstock.

The Examiner argues that it is obvious to modify the Frame process to include certain of the feed stream compositions disclosed by Mahadev and by Yoo. It is respectfully submitted, however, that the modifications of the primary Frame reference in the manner suggested by the

Examiner using the disclosures of Mahadev and Yoo is not proper. The processes taught by the secondary references of Mahadev and Yoo are substantially different from the process of Frame and the catalysts, as well, are substantially different. The Mahadev process is a two-step process involving the absorption of sulphur compounds from a fluid stream and then the subsequent decomposition of such compounds into elemental sulfur. See page 3, line 16-20. This is a significantly different process from the Frame process. The Mahadev catalyst is also significantly different from the Frame catalyst in that the Mahadev catalyst is an alkali metal sulphide and sulphide or selenide of metal having polyvalent and/or amphoteric character on a microporous support. See e.g., Abstract; page 3, lines 28-31; claim 7. This catalyst is not even remotely similar to the Frame catalyst.

Also, in regard to the Yoo disclosure, as noted above the Yoo process is a two-step process that is significantly different from the Frame process. And, again, the Yoo catalyst is in no way similar to the catalyst of the Frame disclosure. There is just no suggestion in the Yoo reference of its teaching being properly combinable with those of the Frame patent.

The examiner also argues that the Applicants' recited metals concentration range does not support the patentability of the claimed subject matter, presumably, because, the Examiner assumes that there must be evidence presented to establish the criticality of the concentration range. The MPEP section cited and relied upon by the Examiner to support his proposition is not, however, properly applicable in the instant case. The MPEP section addresses situations involving optimization of ranges within known prior art ranges that may be determined through routine experimentation. This, however, is not the situation with the instant claims, which are directed to a process for the selective oxidation of sulphur in hydrocarbon feedstock by the use of a specifically defined catalyst composition that has a significantly different composition than those used in the prior art for the particularly claimed process application. But, in any event, the ranges presented in the Applicants' specification are such that outside the recited ranges the catalyst will probably not adequately perform as is required by the process. Therefore, the Examiner's objection regarding the criticality of the recited metals concentration range is not proper.

The Examiner indicates that for the purposes of searching and applying the prior art, he is to treat the transitional phrase "consisting essentially of" as if it is equivalent to the term "comprising" in the absence of a clear indication of the basic and novel characteristics of the

invention. The Applicants' specification, though, does clearly present the basic and novel characteristics of the catalyst.

For example, presented in Example 1 are details concerning the catalyst of the invention and of a comparative catalyst. See paragraphs [0030] – [0045]. As described in Example 1, the inventive catalyst includes a support particle of zirconia that is partially stabilized with yttria (Y-PSZ). The support particles may be painted with a zirconia paint and impregnated with at least one or more of either rhodium, iridium, zirconium, or cerium. Presented in Table 1 is performance data for the inventive catalyst and for the comparison catalyst. The data show that the inventive catalyst provides for a higher H<sub>2</sub>S conversion for a given reaction temperature than does the comparison catalyst, and the selectivity is significantly different as well. See paragraph [0045] and Table 1. The specification also suggests that the catalyst provides for a lower reaction temperature for carrying out the oxidation of sulfur compounds and that at these lower temperatures the oxidation of the sulfur compounds takes preference over the oxidation of hydrocarbons. See paragraph [0019].

The specification clearly provides much discussion of the basic and novel characteristics of the catalyst of the inventive process.

In view of the above comments, it is respectfully submitted that claims 1-2, 9, 11-21, and 24 are patentable over the prior art.

**§103(a) Rejection of claims 1-2, 9, 11-21, and 24 over De Jong (US 5,720,901), as evidenced by Clavenna (US5,476,877).**

The process taught by De Jong relates to the catalytic partial oxidation of hydrocarbons to what is known in the art as synthesis gas, i.e., carbon monoxide and hydrogen. See column 1, lines 5-20. This is not the same as and is a significantly different process or reaction than the Applicants', which relates to the catalytic selective oxidation of sulfur compounds contained in a hydrocarboneous feedstock. It is the goal of the Applicants' process to selectively oxidize the sulfur compounds to SO<sub>2</sub> without the oxidation of the hydrocarbons. But, on the other hand, the De Jong process involves the oxidation of hydrocarbons. These are completely different processes. De Jong indicates that a catalyst which may be used in its process comprises a catalytically active Group VIII metal. See column 5, line 65 – column 6, line 6. De Jong further states that the most suitable catalyst for its process comprises ruthenium, rhodium or iridium as the catalytically active metal . See column 6, lines 6-10. A suitable carrier material may include

the refractory oxides, such as silica, alumina, titania and mixtures thereof. See column 6, lines 11-17. The active metal may be deposited on the carrier by known techniques in an amount in the range of from 0.01 to 20% by weight. See column 6, lines 18-30.

One major difference between the De Jong process and the Applicants' process is that the De Jong process involves the oxidation of hydrocarbons, but the Applicants' process, instead, involves the oxidation of sulfur compounds to sulfur dioxide. De Jong states that the catalyst compositions suitable for use in the catalytic partial oxidation of hydrocarbons are known in the art. See column 5, lines 65-66. The preferred catalysts for use in the De Jong process are described in general terms. De Jong does not mention the use of a yttria stabilized zirconia carrier with the particular combination of active metals of the Applicants' catalyst.

The Clavenna et al. disclosure teaches the use of a low silica content, yttria-stabilized zirconia as a support for a catalyst used in the preparation of synthesis gas.

There is no combination of the De Jong and Clavenna references that will result in providing the Applicants' claimed inventive process. The processes of the cited references are directed to the use of the catalyst compositions described therein in the production of synthesis gas. The Applicants' process, on the other hand, is directed to the catalytic selective oxidation of sulfur compounds contained in a hydrocarbon feedstock to sulfur dioxide. These are significantly different processes.

Any combination of the cited references clearly fails to disclose and teach each and every feature of the Applicants' claimed invention, and, thus, it is respectfully submitted that claims 1-2, 9, 11-21, and 24 are patentable over the references of De Jong and Clavenna.

**§103(a) Rejection of claims 25, 26, 30, and 33-44 over De Jong (US 5,720,901), in view of D'Souza (US 4233,276), as evidenced by Clavenna (US5,476,877).**

The De Jong reference is discussed above. Concerning the D'Souza et al. patent, the disclosure relates to a process for the removal of oxidizable sulfur compounds from a waste gas by oxidizing the sulfur compounds of the waste gas and contacting the gas with the oxidized compounds with a metal oxide absorbent while simultaneously cracking a hydrocarbon, regenerating the spent metal oxide absorbent, and contacting the absorbent with steam.

It is respectfully submitted that the combination of references as presented by the Examiner fails to show all of the claimed elements and features of the Applicants' claimed

process. It further appears that the Examiner has not applied any of the teachings of the third recited reference of Clavenna et al. in making this rejection.

In view of the above, it is respectfully submitted that the claims 25, 26, 30, and 33-44 are patentable over the cited references.

### **New Claims 65-94**

The new claims 65-94 depend either directly or indirectly from one of the independent claims 45, 48 and 51. These claims have been amended to place them in independent form and, based on the Examiner's indication, are believed to be in allowable form.

### **Conclusion**

In view of the amendments and the above comments, it is submitted that claims 1-2, 9, 11-21, 24-26, 30, 33-94 are allowable and, therefore, early allowance thereof is respectfully requested.

Respectfully submitted,

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